

GAO

Report to the Chairman, Subcommittee
on Strategic Forces, Committee on
Armed Services, and to the Honorable
Robert C. Smith, U. S. Senate

May 2000

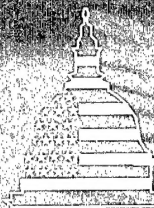
DEFENSE ACQUISITIONS

Improvements Needed in Military Space Systems' Planning and Education



DISTRIBUTION STATEMENT A:
Approved for Public Release -
Distribution Unlimited

20000519 026



GAO

Accountability • Integrity • Reliability

Contents

Letter	3
--------	---

Executive Summary	4
-------------------	---

Chapter 1	14
Introduction	
Policies Contain Broad Guidelines for Expanding Military Space Systems	15
Long-Range Plan Provides Vision for Expanding Military Space Systems	16
Air Force Spends Most of the Defense Space Funds	17
Attention on DOD Space Management and Organization	19
Objectives, Scope, and Methodology	21

Chapter 2	24
Inadequacies in Space Planning	
Plans for Expanding Space Systems Do Not Fully Conform to DOD Policy	24
Space Architect's Master Plan Will Not Fully Comply With DOD Policy Guidelines	26

Chapter 3	28
Affordability of Planned Space Systems Is Questionable	
Extent of Air Force Funding Support for Planned Space Systems Could Not Be Verified	28
Availability of Funds to Acquire Planned Space Systems Is Uncertain	29

Chapter 4	33
Insufficient Attention to Space Education	
Military Forces Still Depend on Temporary Space Support Teams	33
Policy on Space-Educated Force Is Formalized, but Doctrine Is Not Issued	34
Space Education Curricula Varies	35

Chapter 5	40
Conclusions, Recommendations, and Agency Comments	
Conclusions	40
Recommendations	40
Agency Comments	41

Contents

Appendixes

Appendix I: Comments From the Department of Defense	44
Appendix II: GAO Contacts and Staff Acknowledgments	47

Tables

Table 1: Number of Space Support Teams' Activities From August 1998 to August 1999	34
Table 2: DOD and Military Service Colleges and Schools and Number of Solely Space-Related Courses or Lessons	37

Figures

Figure 1: Defense Space Funding for Fiscal Years 1994-2005	18
Figure 2: Air Force Space Funding Projections for Fiscal Years 2000-17	30

Abbreviations

DOD	Department of Defense
GAO	General Accounting Office



United States General Accounting Office
Washington, D.C. 20548

National Security and
International Affairs Division

B-281496

May 18, 2000

The Honorable Wayne Allard
Chairman
Subcommittee on Strategic Forces
Committee on Armed Services

The Honorable Robert C. Smith
United States Senate

In response to a request from your subcommittee, this report discusses DOD's approach to implementing the U.S. Space Command's long-range plan for expanding military space systems in the 21st century. This report contains recommendations to the Secretary of Defense.

We are sending copies of this report to Senator Daniel K. Inouye, Senator Carl Levin, Senator Ted Stevens, Senator John W. Warner, Representative Jerry Lewis, Representative John P. Murtha, Representative Ike Skelton, and Representative Floyd D. Spence in their capacities as Chairs or Ranking Minority Members of Senate and House Committees. We are also sending copies of this report to the Honorable William S. Cohen, Secretary of Defense; the Honorable F. Whitten Peters, Secretary of the Air Force; the Honorable Richard Danzig, Secretary of the Navy; the Honorable Louis Caldera, Secretary of the Army; and the Honorable Jacob Lew, Director, Office of Management and Budget. Copies will be made available to others upon request.

Please call me at (202) 512-4841 if you or your staff have any questions concerning this report. Major contributors to this report are listed in appendix II.

Louis J. Rodrigues
Director, Defense Acquisitions Issues

Executive Summary

Purpose

The increasing use of military and commercial satellite systems for national security and business purposes will have significant implications for the United States in the 21st century. The Department of Defense (DOD) has traditionally used satellite systems in passive roles to support military operations—for example, to collect intelligence data, warn of ballistic missile launches, transmit voice and data communications, obtain meteorological data, and provide navigation signals. Now, plans are being developed to expand the use of military satellite systems and develop technologies such as lasers and electronic jammers that could be used to actively conduct combat operations from space. With advances in information technology, the commercial use of satellites is also expanding, particularly in telecommunications. In addition, single satellite systems—for example, navigation, environmental, and imagery systems—that originally served government missions, are increasingly providing capabilities to both government and commercial users. The non-government applications are now generating large amounts of commercial revenue. National space policy treats U.S. satellite systems as national property that organizations have the right to operate without deliberate interference. To the extent that such interference were to occur, the U.S. Space Command visualizes that military forces may be called upon to provide protection, just as navies protected sea commerce and armies protected the nation's expansion westward during earlier centuries.¹

The Chairman, Subcommittee on Strategic Forces, Senate Committee on Armed Services, requested that GAO review DOD's approach to implementing the U.S. Space Command's March 1998 long-range plan for expanding military space systems. Specifically, GAO evaluated the extent to which (1) plans for expanding military space systems conform to national and defense space policies, (2) funding projections support planned military space programs and desired capabilities, and (3) actions are being taken to educate military personnel to support future military space operations.

¹The U.S. Space Command is a unified combatant command of DOD that was activated in 1985 to consolidate all military space efforts under one commander in chief who is directly responsible to the President through the Secretary of Defense and the Chairman of the Joint Chiefs of Staff.

Background

In 1996, the President issued new national space policy that contained broad guidelines for conducting national security (defense and intelligence) and civil space activities and for supporting the expansion of commercial space investments.² In 1999, DOD revised its space policy, augmenting the defense portion of the national space policy.³ Included among several topics in DOD's policy are (1) a declaration that space—like land, sea, and air—is a medium within which military activities shall be conducted to achieve national security objectives; (2) planning guidelines requiring that desired space systems be assessed against alternative terrestrial systems from a cost-effectiveness viewpoint, using modeling and simulation tools to demonstrate the desired space system's military worth; and (3) directions for incorporating information about the structure, missions, capabilities, and applications of space forces into professional military education.⁴ Together, the national and DOD space policies provide considerable latitude for supporting military space systems and expanding them as the need arises.

The U.S. Space Command's 1998 long-range plan, which predates DOD's revised policy, proposed a variety of new space systems through 2020, including a space-based radar, space-based laser, space-based jammer, space-based data relay, space maneuvering vehicle, and space operating vehicle. Many of the technologies called for in the plan have not been developed; system costs are uncertain; and potential system effectiveness will need to be assessed. In addition, the long-range plan proposed that information about the use of space systems be formally integrated into professional military education curricula, where space would be designated a special area of emphasis at the DOD and military services' colleges and schools. The educational focus would be on how satellite systems enhance warfighting.

²*National Space Policy*, Presidential Decision Directive-National Security Council-49/National Science and Technology Council-8 (Sept. 14, 1996).

³DOD's space policy was established as DOD Directive 3100.10 (July 9, 1999), which canceled the previous space policy established in 1987.

⁴Space forces are defined as systems, equipment, facilities, organizations, and personnel necessary to access, use, and, if directed, control space for national security purposes.

The U.S. Space Command depends on the military services to support its long-range plan. Although the Command is responsible for establishing operational requirements, the services' are responsible for satisfying these requirements to the maximum extent practicable through their planning, programming, and budget system.⁵ The Air Force is DOD's primary procurer and operator of space systems, having received over 80 percent of defense space funds during the last 6 years—averaging about \$5 billion annually—and expecting to receive an average of \$6 billion annually during the next 6 years. Its subordinate command—the Air Force Space Command—prepares a strategic master plan to support the U.S. Space Command's long-range plan. The strategic master plan provides guidance for Air Force headquarters staff to use in preparing an 18-year program projection, which contains all programs the Air Force intends to pursue, including space programs.

During the past 6 years, DOD's management and organization of space programs and activities have drawn increased attention. In 1994, DOD responded to congressional concerns about the lack of a coherent national security space management structure by consolidating certain space management functions within a new Office of the Deputy Under Secretary of Defense for Space. However, in 1998, under a defense reform initiative, DOD disestablished this office and dispersed the management functions among existing DOD offices—primarily the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence and the Under Secretary of Defense for Acquisition, Technology, and Logistics. DOD's organizational management of space programs and activities remains an issue with the Congress. During deliberations on the fiscal year 2000 defense budget, the Senate Committee on Armed Services expressed concern about DOD's present ability to fully exploit space for national security purposes. It stated that DOD approaches space as an information medium to support existing land, sea, and air forces rather than as a strategic location from which to project power. As a result, in October 1999, the Congress authorized the establishment of a space commission to assess a variety of space management and organization issues out of concern about DOD's approach to these matters. Among several duties of the commission are assessing (1) the potential costs and benefits of establishing various space organizational structures; (2) the manner in

⁵DOD's planning, programming, and budgeting system is a resource allocation process for making decisions on policy, strategy, and the development of forces and capabilities to accomplish anticipated missions.

which military space assets may be exploited for military operations; and (3) the manner in which military space issues are addressed in professional military education institutions. The commission is to be organized in early 2000.⁶

Results in Brief

The U.S. Space Command's long-range plan and the Air Force Space Command's supporting strategic master plan provide for the protection of U.S. national interests and investments in space, but they do not fully conform to DOD's new space policy. The plans propose space systems only and do not provide for an assessment of the cost-effectiveness of terrestrial—land, sea, and air—systems as alternatives to space systems, which is called for in DOD's policy. An example of such a comparative assessment would be between satellite and aircraft radar systems. In addition, DOD lacks the modeling and simulation tools necessary to perform such assessments, a capability that is also called for in DOD's space policy. Finally, it is unclear which DOD organization has the authority and capability to perform comparative assessments between space and terrestrial systems since such assessments are outside the purview of the U.S. and Air Force Space Commands. These factors prevent DOD from being assured that the most cost-effective approaches will be considered in making decisions on the expansion of space systems.

The extent to which the Air Force's 18-year program projection supports planned military space programs and desired capabilities was unverifiable. Although several of the planned space systems, such as a space-based radar and a space-based laser, are included in the Air Force's program projection, the cost estimates in the Air Force Space Command's strategic master plan were not directly traceable to the 18-year program funding projections. They were not traceable because the data were aggregated differently and program nomenclatures differed. Air Force Space Command representatives stated that they intend to institute changes to bring about consistency between the documents. A more important matter is uncertainty about the availability of several billions of dollars in funding increases that the Air Force has projected for space system expansion. During the first 6 years of the 18-year projection (fiscal years 2000-05), programmed increases are uncertain because the President and the Congress have not agreed on overall funding increases to DOD. During the

⁶National Defense Authorization Act for Fiscal Year 2000, sections 1621-30 (P.L. 106-65, Oct. 5, 1999).

last 12 years of the projection (fiscal years 2006-17), the Air Force relies on planned funding increases for program modernization without identifying funding sources, thus creating additional uncertainty and putting the expansion of space systems in jeopardy for affordability reasons.

DOD has not given sufficient attention to providing military personnel with space education to support future military space operations. DOD's new space policy requires that information about space force structure, missions, capabilities, and applications be incorporated into professional military education. However, joint military doctrine on space operations that is necessary to implement the policy has not been issued because of disagreement among the services on the doctrine's content.⁷ Leaving the disagreement unresolved hinders common understanding for the use of space systems in military operations. In addition, until the doctrine is provided, DOD and military service educational institutions will lack guidance for the development of space education curricula and for determining whether existing curricula need to be modified.

This report contains recommendations to the Secretary of Defense that would (1) require space plans to include analyses of terrestrial systems as alternatives, (2) establish the necessary modeling and simulation tools to perform such analyses, (3) identify and/or establish the DOD office to perform the analyses, (4) address the delay in completing joint doctrine for space operations, and (5) provide the necessary instructions to DOD and military service colleges and schools for incorporating essential space information into professional military education curricula. DOD concurred with our recommendations and provided comments.

Principal Findings

Inadequacies in Space Planning

The U.S. Space Command's long-range plan and the Air Force Space Command's supporting strategic master plan propose to expand space systems to protect U.S. national interests and investments in space. However, DOD's approach to space planning is inadequate. Neither plan considered the use of terrestrial—land, sea, and air—systems as

⁷The purpose of joint military doctrine is to provide the fundamental principles for guiding the employment of forces of two or more services toward a common objective.

alternatives to their proposed space systems. DOD's 1999 space policy, which was published after the plans were developed, calls for an objective assessment of space systems by requiring the identification of missions, functions, and tasks that could be performed more efficiently and effectively (meaning cost-effectively) by space forces than by terrestrial alternatives.

In addition, DOD lacks the modeling and simulation tools that are necessary to comparatively assess the efficiency and effectiveness of space systems with plausible terrestrial system alternatives. The U.S. Space Command states that this deficiency not only impairs its ability to effectively plan, but also significantly affects its ability to articulate the benefits of space systems. In DOD's 1999 space policy, modeling and simulation is a requirement for demonstrating the military worth of space systems and their application to mission accomplishment.

Finally, DOD has not identified the organization that should be responsible for performing comparative assessments between space and alternative terrestrial systems. The U.S. Space Command is not likely to be the appropriate organization because it is DOD's primary proponent for space systems. Similarly, the military services may not be ideally suited for this role because the alternative terrestrial systems that should be considered may not be within their purview. The Air Force, for example, may be able to make trades between space and air systems, but may not be the appropriate organization for making trades between space and land or sea system alternatives.

These three matters—no analyses of terrestrial systems alternatives, no modeling and simulation tools to perform such analyses, and no clearly responsible organization to perform such analyses—may be of interest to the space commission as it assesses the manner in which military space assets may be exploited for military operations.

Affordability of Planned Space Systems Is Questionable

The Air Force's 18-year program projection for fiscal years 2000-17 provides funding for several space programs that are contained in the U.S. Space Command's long-range plan and the Air Force Space Command's supporting strategic master plan. As the primary procurer of DOD space systems, the Air Force has to balance the funding projections for planned space programs with nonspace programs such as aircraft and missiles. Therefore, not all of the space programs identified in the plans can be

included in the 18-year projection and particularly not at the level estimated by the Air Force Space Command.

Additionally, the availability of the Air Force's projected funding is uncertain, raising a question about the likelihood of planned space systems being funded at the necessary level. For the 6 fiscal years within its 2000-05 future years defense program, DOD expects to receive increased funds from the anticipated government budget surplus.⁸ However, DOD's prospects of receiving an increase depend on the actual accumulation of surplus funds and on an agreement between the President and the Congress about DOD sharing in the surplus. In the event that such programmed funds are not received, the requirements for these funds are likely to be shifted to later years, creating an accumulated demand for funds known as a "bow wave." Such demand raises the prospects that the planned space systems may not be affordable and is therefore a source of risk in achieving system modernization.⁹

Adding to this uncertainty, the Air Force has projected an increase in funds for modernization programs at the rate of 1.5 percent annually for the last 12 fiscal years of its program projection (2006-17). According to Air Force officials, this approach allows for flexibility to introduce new programs into the planning process without searching for alternative funding sources, and it also reflects a need for additional obligation authority. Relying on a projected increase adds to the uncertainty regarding the availability of funds, which increases doubt about the affordability of space system expansion.

Insufficient Attention to Space Education

The U.S. Space Command's 1998 long-range plan states that information about the use of space systems should be designated a special area of emphasis in professional military education because many military personnel (commissioned officers) do not understand the importance of such systems to military operations. Also, in 1998, the Joint Staff advised

⁸DOD's future years defense program summarizes forces and resources associated with programs approved by the Secretary of Defense and supports the President's annual defense budgets.

⁹See *Future Years Defense Program: Funding Increase and Planned Savings in Fiscal Year 2000 Program Are at Risk* (GAO/NSIAD-00-11, Nov. 22, 1999) and *Future Years Defense Program: Substantial Risks Remain in DOD's 1999-2003 Plan* (GAO/NSIAD-98-204, July 31, 1998).

DOD and military service postgraduate colleges and schools to emphasize information about space because it had not been adequately included in professional military education curricula. The emphasis that these colleges and schools have given to space education varies. For example, Air Force and Navy colleges offer a larger number of courses or lessons that are solely space-related than Army and Marine Corps colleges offer.

DOD's 1999 space policy requires that space information be incorporated into professional military education. However, joint military doctrine that would provide the essential implementing guidelines for planning and conducting operations using space forces has not been issued. An effort to develop such doctrine has been ongoing for 10 years, but has not been completed because of disagreement among the services about the doctrine's content. Without the appropriate doctrinal guidance, there is insufficient assurance that the proper space knowledge is being imparted to military officers. Progress toward rectifying this matter may be of interest to the space commission as it assesses the manner in which military space issues are addressed in professional military educational institutions.

Meanwhile, DOD is still depending on space support teams to provide the necessary information to military forces about the use of space systems. The U.S. Space Command and the military services established these teams after the 1991 Persian Gulf War to provide operational support, education, and training to military forces. They were intended to be temporary until a space-educated military force was in place.

Recommendations

To ensure that the most cost-effective decisions are made in regard to planning and programming for space systems, GAO recommends that the Secretary of Defense direct the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence and, as appropriate, the Under Secretary of Defense for Acquisition, Technology, and Logistics to (1) require that plans in support of space systems include analyses of estimated costs and potential effectiveness of plausible terrestrial—land, sea, and air—systems as alternatives for performing the identified space missions, functions, or tasks and (2) establish the means to develop and employ the modeling and simulation tools necessary to perform comparative analyses of space and terrestrial systems. Because the military services can only analyze space and terrestrial systems that are within their organizational purview, the Secretary should also identify and/or establish

the proper office, and provide the necessary authority, to perform such analyses for decisionmakers on a DOD-wide basis.

To ensure that military personnel are adequately educated in the use of space systems for military operations, GAO recommends that the Secretary of Defense direct the Chairman of the Joint Chiefs of Staff to (1) address the delay in completing joint doctrine for space operations by resolving differences among the services and establishing a time frame for issuance and (2) provide the necessary instructions to DOD and military service colleges and schools for incorporating essential space information into their professional military education curricula.

Agency Comments

DOD provided written comments on a draft of this report, which appear in appendix I. DOD concurred with GAO's recommendations.

Regarding the need to perform analyses of terrestrial alternatives in planning for space systems, the use of modeling and simulation tools to aid in the analyses, and the proper office to perform such analyses, DOD stated that GAO's recommendations are, at least in principle, being implemented through existing departmental procedures, specifically citing directions within its acquisition management system. To the extent that DOD can implement GAO's recommendations within its acquisition management system, the results should be favorable. However, the evidence in this report indicates that analyses of terrestrial alternatives in long-range space planning has not been performed; modeling and simulation tools are deficient for performing such analyses, and current efforts to acquire such tools are limited because of funding constraints; and the organizational structure for dealing with space as a medium for conducting military operations has not been fully addressed. As a result, we believe our recommendations are still valid and need to be directly addressed by DOD.

Regarding the need to provide adequate education of military personnel in the use of space systems for military operations, DOD stated that a review would be performed, under the direction of the Chairman of the Joint Chiefs of Staff, to provide guidance for essential space information that must be present in professional military education and training.

Introduction

Increasing military and commercial use of, and dependence on, space systems for national security and business purposes will have significant implications for the United States in the 21st century. The Department of Defense (DOD) has traditionally used satellites in passive roles to support military operations—for example, to collect intelligence data, warn of ballistic missile launches, transmit voice and data communications, obtain meteorological data, and provide navigation signals. Now, plans are being developed to expand the use of military satellite systems and develop technologies (such as lasers and electronic jammers) that could be used to actively conduct combat operations from space.

With advances in information technology, the commercial use of satellites is also expanding, particularly in telecommunications, to transmit news, financial transactions, and entertainment. A May 1999 forecast predicted that between 2000 and 2010, more than 1,200 commercial satellites may be launched.¹ Also, government and commercial uses of single satellite systems (such as navigation, environmental, and imagery systems) are converging, where the original purpose was for government missions, nongovernment applications are now generating large amounts of commercial revenue. For example, according to the U.S. Space Command, nongovernment applications of DOD's navigation satellite system—the Global Positioning System—will generate \$16 billion in commercial revenue by 2003.

National space policy treats U.S. satellite systems as national property that organizations have the right to operate without deliberate interference. To the extent that such interference were to occur, the U.S. Space Command visualizes that military space forces may be called upon to provide protection, just as navies protected sea commerce and armies protected the nation's expansion westward during earlier centuries. Excluding space programs for intelligence purposes, DOD has spent an annual average of \$5.9 billion on space programs and activities during the past 6 years, and it has programmed an annual average of \$6.9 billion during the next 6 years—a 17-percent increase primarily for modernization purposes. Also, during the past 6 years, DOD management and organization of space programs and activities have drawn increased attention from the Congress. Recently, the Congress authorized the establishment of a space commission to assess DOD's approach to national security space management and organization.

¹1999 *Commercial Space Transportation Forecasts*, Federal Aviation Administration and the Commercial Space Transportation Advisory Committee (May 1999).

Policies Contain Broad Guidelines for Expanding Military Space Systems

In September 1996, the President issued new national space policy that contained broad guidelines for conducting national security (defense and intelligence) and civil space activities and for supporting the expansion of commercial investments.² For national security, the policy identified the following key priorities: improving the United States' ability to support military operations worldwide, monitoring and responding to strategic military threats, and monitoring arms control and nonproliferation agreements and activities. In addition, the policy stated that such space activities are expected to (1) provide support for the United States' right of self-defense; (2) deter, warn, and defend against enemy attack; (3) ensure that hostile forces cannot prevent the United States' use of space; and (4) counter space systems used for hostile purposes. Also, the policy provided that critical capabilities necessary for executing national security space missions must be assured and that this requirement will be considered and implemented at all stages of architecture and system planning, development, acquisition, operation, and support.³

In July 1999, DOD revised its space policy that augments the defense portion of the national space policy and established more specific guidelines for the conduct of space activities by the military services.⁴ A major objective for the revision was to address changes that have taken place since DOD's previous space policy was issued in 1987 during the Cold War. DOD identified some of these changes as (1) the transformation of the international security environment, (2) the promulgation of new national security and national military strategies, (3) an adjustment in the resources allocated to national defense, (4) lessons learned from the operational employment of space assets, (5) advances in military and information technologies, and (6) growth of commercial space activities. DOD's revised policy declares that space—like land, sea, and air—is a medium within which military activities shall be conducted to achieve U.S. national security objectives and that the ability to access and use space is of vital national interest. According to the revised policy, U.S. space systems are

²*National Space Policy*, Presidential Decision Directive-National Security Council-49/National Science and Technology Council-8 (Sept. 14, 1996).

³Space architectures describe relationships among space systems that perform functions to achieve desired missions at designated performance levels, thus providing a long-term framework to guide detailed planning.

⁴DOD's revised space policy was established as DOD Directive 3100.10 (July 9, 1999); it canceled previous space policy that was established in 1987.

national property that organizations have the right to operate in space without interference—deliberate interference being viewed as an infringement on the nation's sovereign rights and justifying appropriate self-defense measures, including the use of force.

DOD's revised policy also includes guidelines on (1) planning for space activities, including assessing the cost-effectiveness of desired space systems against terrestrial alternative systems; (2) translating operational needs into programs where mission effectiveness would be enhanced by space systems relative to other media, such as land, sea, and air; (3) using modeling and simulation tools to demonstrate the desired space system's military worth; and (4) incorporating information about space forces into professional military education to provide appropriately educated and trained personnel at all levels of joint and component military organizations.⁵ Together, the national and DOD space policies provide considerable latitude not only for supporting military space systems, but also for expanding them as the need arises.

Long-Range Plan Provides Vision for Expanding Military Space Systems

As DOD's focal point for military space operations, the U.S. Space Command coordinates the use of Air Force, Navy, and Army space forces to perform space missions, including launching and operating satellites and supporting joint military forces with information from satellites. It also establishes space requirements on behalf of DOD's unified commands. In March 1998, the Command developed a long-range plan for expanding military space systems into the 21st century. The plan, which extends to 2020, proposed a variety of new space systems, such as a space-based radar, space-based laser, space-based jammer, space-based data relay, space maneuvering vehicle, and space operating vehicle. Many of the technologies called for in the plan have not been developed; system costs are uncertain; and potential system effectiveness will need to be assessed.

In developing the plan, the Command envisioned the growth of space power during the next decade as being similar to the growth of air power during the first half of the 20th century. During that period, military air power evolved from a role of supporting land and sea operations to performing air combat and then to strategically projecting force on a battlefield. Similarly, military space systems have supported land, sea, and

⁵Space forces are defined as systems, equipment, facilities, organizations, and personnel necessary to access, use, and if directed, control space for national security purposes.

air operations during the last 40 years, but the Command envisioned such systems as moving toward a medium of warfare where combat operations would be performed in space and where force would be projected from space to earth. Also, the Command envisioned that space forces might be called upon to protect the nation's increasing use of commercial space systems, just as navies protected sea commerce and armies protected the nation's expansion westward during earlier centuries.

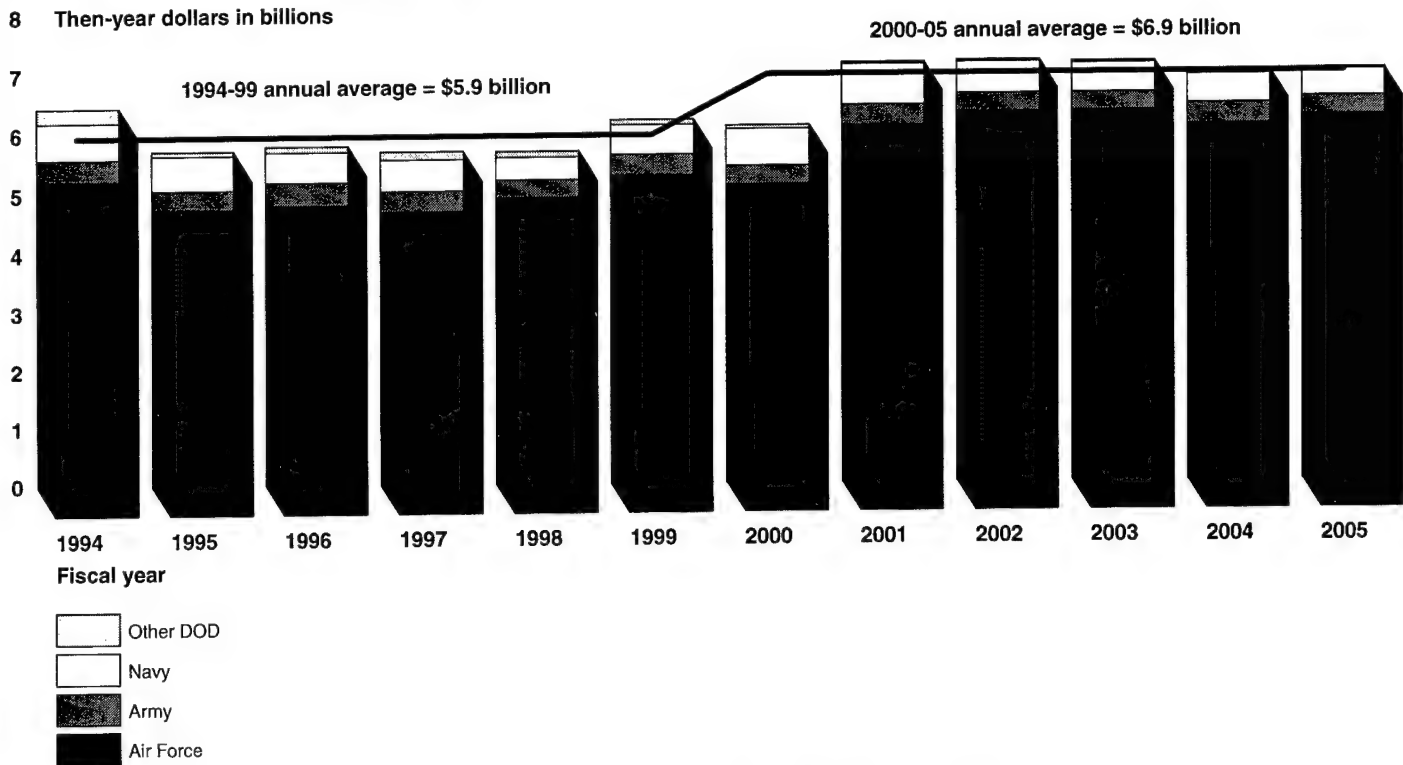
The Command depends on the military services to support its long-range plan. Although the Command has the responsibility for establishing operational requirements, the services are responsible for satisfying the requirements to the maximum extent practicable through their planning, programming, and budgeting system.⁶ For example, within the Air Force, the Air Force Space Command prepares a strategic master plan to support the long-range plan. The strategic master plan provides program and budget guidance to Air Force headquarters staff, who prepare an 18-year program projection that establishes programs the Air Force intends to pursue, including space programs.

Air Force Spends Most of the Defense Space Funds

Information from DOD's Office of the Comptroller shows that actual annual funding of space programs and activities for fiscal years 1994-99 ranged from \$5.7 billion to \$6.4 billion. For fiscal years 2000-05, annual defense space funding is programmed to range from \$6.0 billion to \$7.1 billion. The annual funding average for the past 6 years was \$5.9 billion, and the projected annual average for the ensuing 6 years is \$6.9 billion. Thus, DOD expects a total increase of about \$6 billion for the next 6 years. Figure 1 shows the 6-year history and the 6-year projection.

⁶DOD's planning, programming, and budgeting system is a resource allocation process for making decisions on policy, strategy, and the development of forces and capabilities to accomplish anticipated missions.

Figure 1: Defense Space Funding for Fiscal Years 1994-2005



Note: Excludes space funding for intelligence programs.

Source: DOD's Office of the Comptroller.

The Air Force is DOD's primary procurer and operator of space systems, and accordingly, it spends the largest share of defense space funds. For fiscal years 1994-99, the Air Force's actual share averaged 83 percent of total space funding, whereas the Navy, the Army, and other Defense agencies' average shares were 9 percent, 6 percent, and 2 percent, respectively. For fiscal years 2000-05, the Air Force's share averages 87 percent of total programmed space funding, reflecting increases for satellite and launch vehicle modernization, whereas the Navy, the Army, and other Defense agencies' average shares are 8 percent, 5 percent, and less than 1 percent, respectively.

Attention on DOD Space Management and Organization

During the past 6 years, DOD's management and organization of space programs and activities have drawn increased attention, and DOD took action to reorganize on two separate occasions—in 1994, in response to congressional concerns, and in 1998, under a defense reform initiative. In October 1999, the Congress authorized the establishment of a commission to assess U.S. national security space management and organization because of ongoing concern about DOD's approach to these matters.⁷

Congressional Concern Prompted Initial Space Management Reorganization

In a 1994 report, we discussed congressional concerns about the lack of a coherent management structure for national security space programs.⁸ In response to these concerns, DOD established the Office of the Deputy Under Secretary of Defense for Space to consolidate, in a single organization, all existing Office of the Secretary of Defense responsibilities and functions for space policy, architectures, and acquisition management. DOD finalized its decision in 1995, establishing the Deputy Under Secretary of Defense for Space as the principal assistant and advisor for space matters. A priority of the new office was to develop a national security space master plan to coordinate and implement the policies and operational concepts that would be pursued into the 21st century. However, according to DOD officials, the master plan was not completed because a consensus could not be reached among space proponents about conclusions and recommendations. Instead, an agreement was reached on long-range planning objectives to guide the development of future space plans.

Also in 1995, DOD established an Office of the Space Architect to consolidate within a single organization the responsibilities for developing space architectures across the range of DOD space mission areas. The purpose was to achieve efficiencies in acquisition and future operations through program integration. The Deputy Under Secretary of Defense for Space was to provide policy guidance and oversight to the Architect for the development of integrated space architectures. Such proposed architectures were to be submitted to the Defense Acquisition Executive

⁷National Defense Authorization Act for Fiscal Year 2000, sections 1621-30 (P. L. 106-65, Oct. 5, 1999).

⁸*National Space Issues: Observations on Defense Space Programs and Activities* (GAO/NSIAD-94-253, Aug. 16, 1994).

(who is also the Under Secretary of Defense for Acquisition, Technology, and Logistics) for approval.

Defense Reform Initiative Prompted Most Current Space Management Reorganization

In 1998, as part of an overall defense reform initiative, DOD disestablished the Office of the Deputy Under Secretary of Defense for Space. As a result, the policy, architectures, and acquisition management responsibilities of the Deputy Under Secretary of Defense for Space were dispersed to other offices within the Office of the Secretary of Defense. Specifically, the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence now (1) serves as the principal staff assistant and advisor for space matters, (2) develops and oversees the implementation of space policies in coordination with the Under Secretary of Defense for Policy, and (3) oversees the development and execution of space architectures and acquisitions, in coordination with the Under Secretary of Defense for Acquisition, Technology, and Logistics, who serves as the acquisition executive for major defense acquisition programs and technology development.

Also in 1998, the functions of the Office of the DOD Space Architect and architectural elements of the National Reconnaissance Office were consolidated into a new Office of the National Security Space Architect. In a memorandum of understanding between the Secretary of Defense and the Director of Central Intelligence, the new architect was given responsibility for developing and integrating mid- and long-term space architectures across the range of DOD and intelligence community mission areas. This included further development of the national security space master plan that had been initiated by the Deputy Under Secretary of Defense for Space under the previous reorganization. The new architect reports to the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence and to the Deputy Director of Central Intelligence.

Congressional Concern Prompts Establishment of Space Commission

In 1999, during deliberations on the fiscal year 2000 defense budget, the Senate Committee on Armed Services expressed concern about DOD's present ability to fully exploit space for national security purposes. The Committee believed that DOD approaches space as an information medium to support existing land, sea, and air forces rather than as a strategic location from which to project power. As a result, the Committee concluded that an independent commission of experts would be better suited than DOD to look beyond existing programs, policies, and organizational structures for opportunities to enhance national security

through a more complete use of space for military purposes. In the National Defense Authorization Act for Fiscal Year 2000, the Congress authorized the establishment of a space commission to assess a variety of management and organization issues, including assessing (1) the potential costs and benefits of establishing various space organizational structures, (2) the manner in which military space assets may be exploited for military operations, and (3) the manner in which military space issues are addressed in professional military education institutions. The commission is to be organized in 2000.

Objectives, Scope, and Methodology

The Chairman, Subcommittee on Strategic Forces, Senate Committee on Armed Services, expressed an interest in how military space strategy would evolve under the U.S. Space Command's long-range plan for expanding military space systems in the 21st century. Factors affecting the question were that (1) commercial dependence on space systems is increasing, (2) the military services have program and budget responsibilities for acquiring DOD space systems, and (3) a cadre of trained personnel would be essential to execute the strategy envisioned in the plan. In this context, the Chairman requested that we review DOD's approach to implementing the Command's long-range plan. As agreed, we evaluated the extent to which (1) plans for expanding military space systems conform to national and defense space policies, (2) funding projections support planned military space programs and desired capabilities, and (3) actions are being taken to educate military personnel to support future military space operations.

The scope of our evaluation included the U.S. Space Command's March 1998 long-range plan; Air Force Space Command's supporting March 1998 strategic master plan; 1996 national space policy; and DOD's 1999 space policy. Although the two plans were published prior to the issuance of DOD's 1999 space policy, we considered the new policy important because of its comprehensive content and relevance to planning for future space systems. DOD's previous 1987 space policy, which was superseded, did not contain an equivalent degree of detailed guidance. Our scope also included the Air Force's fiscal year 2000-17 program projection, which is an 18-year near-, mid-, and long-term programming and planning document that allocates funds and indicates the direction that the Air Force intends to pursue. We concentrated on the Air Force's funding projection because the Air Force spends over 80 percent of the space funds for national defense. Finally, our scope included information on curricula at military colleges

and schools to provide commissioned officers with instruction about space systems and their application to military operations.

To acquire information about planned space systems and supporting funding projections, we reviewed space plans and cost estimates at the U.S. and Air Force Space Commands, Colorado Springs, Colorado, and funding projections at Air Force Headquarters, Washington, D.C. We also reviewed national and DOD space policies. The U.S. Space Command's long-range plan did not contain funding estimates needed for implementation; therefore, we made a comparison of the content between this plan and the Air Force Space Command's supporting strategic master plan. Although the strategic master plan did contain cost estimates, they were not traceable to the Air Force's program funding projections. Thus, we made a comparison of the content between the strategic master plan and the Air Force's 18-year program projection. To gain additional understanding regarding the space plans and funding estimates, we held discussions with, and obtained documentation from, representatives of the Office of the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence, and the Joint Staff, Washington, D.C.; the Office of the National Security Space Architect, Alexandria, Virginia; the Army Space Command, Colorado Springs, Colorado; the Army Space and Missile Defense Command, Arlington, Virginia; the Naval Space Command, Dahlgren, Virginia; and the Naval Space Command Detachment, Colorado Springs, Colorado.

To acquire information about space education for military personnel, we reviewed Joint Chiefs of Staff curricula guidance, draft joint space operations doctrine, military service space master plans, military college curricula, and briefings from military service space support teams. We focused on space education—the general goal of which is to provide an understanding of concepts on how space systems are used in military operations. We did not assess space training—the general goal of which is to teach personnel how to perform tasks such as using equipment to retrieve satellite data—because it would have involved a more extensive scope of work. We held discussions with, and acquired information from, representatives of DOD, Air Force, Navy, Army, and Marine Corps colleges and schools. We also acquired information from the Air Force's Space Warfare Center, Schriever Air Force Base, Colorado, and the Army Space and Missile Defense Command's Force Development and Integration Center, Arlington, Virginia.

We performed our review from December 1998 through November 1999 in accordance with generally accepted government auditing standards.

Inadequacies in Space Planning

The U.S. Space Command's long-range plan and the Air Force Space Command's supporting plan propose expanding military space systems to protect U.S. national interests and investments in space. These plans do not fully conform with DOD's new space policy because they do not provide for an assessment of the cost-effectiveness of terrestrial—land, sea, and air—systems as alternatives to space systems. The National Security Space Architect's latest planning effort also will not consider the cost-effectiveness of terrestrial system alternatives. In addition, DOD lacks the analytical tools needed to assess such alternatives. As a result of these planning inadequacies, DOD cannot be assured that the most cost-effective approaches will be considered in making decisions on the expansion of space systems.

Plans for Expanding Space Systems Do Not Fully Conform to DOD Policy

As space system proponents, the U.S. Space Command and the Air Force Space Command focused on space system solutions only in their respective 1998 long-range plan and strategic master plan. DOD's 1999 space policy requires comparative assessments of space and terrestrial alternatives—the purpose being to determine whether missions, functions, and tasks can be performed more efficiently and effectively, meaning more cost-effectively, by space systems than plausible terrestrial systems. Although the plans were developed before the policy was issued, the policy provides sound planning guidance for making acquisition decisions. U.S. Space Command officials stated that because the long-range plan was designed to identify future capabilities, such comparative assessments were not performed to determine whether the plan was an efficient and effective use of resources. However, they acknowledged that before efforts are made to implement the plan, such analyses should be performed.

An example of where a cost-effectiveness analysis would be critical is in comparing the planned space-based radar system with two aircraft radar systems—all of which look for moving targets. The planned space-based radar system would include a constellation of satellites to detect and track moving targets on the earth's surface, produce high-resolution imagery, and collect precision digital terrain elevation data. DOD's Joint Surveillance Target Attack Radar System is a fleet of modified commercial aircraft that perform ground surveillance of an enemy's situation and supports military attack operations. DOD's Airborne Warning and Control System is a fleet of modified commercial aircraft that collects position and tracking data on enemy aircraft and ships and on the location and status of friendly aircraft and naval vessels. Another example deserving of a cost-effectiveness analysis would be between satellite and airborne laser systems that are

expected to destroy ballistic missiles in flight. The planned space-based laser system would include a constellation of satellites, and the airborne laser system would include a fleet of modified commercial aircraft.

In a 1998 RAND report that dealt with the influence of military and economic space power on national security strategy and the conduct of future military operations, the radar systems were cited as an example of where a trade-off assessment was necessary.¹ The report indicated that the assessment should compare the benefit of avoiding the costs of maintaining aircraft and crews by moving the airborne capabilities to space with the risk associated with ensuring a survivable space system, particularly considering the space system's cost of development and deployment. The Air Force Scientific Advisory Board also discussed the radar example in a 1998 report.² However, the Board stated that DOD has a limited ability to balance capabilities and requirements across space, airborne, and surface elements; for example, it does not have an integrated system-of-systems perspective or the means to do objective, meaningful trade-off analyses among these elements. Also, it is unclear what organization in DOD should perform such analyses. The U.S. Space Command may not be the appropriate organization because it is DOD's proponent for space systems. Also, the military services may not be ideally suited for this role because the plausible alternative terrestrial systems may not be within their purview. For example, it may not be fitting for the Air Force to perform trade-off analyses between space and land communications systems.

DOD's space policy calls for the use of modeling and simulation to demonstrate the military worth of space systems to be acquired. However, DOD representatives informed us that most DOD modeling and simulation tools are deficient in considering alternative systems within single functions and missions. Examples are an inability to perform assessments between (1) military and commercial satellite systems and terrestrial systems for the communications function and (2) satellites and manned and unmanned aircraft for reconnaissance missions. The Air Force Scientific Advisory Board reported this limitation in analytical capability in its 1998 report concerning the characteristics and effectiveness of air and

¹*Space: Emerging Options for National Power*, RAND, National Defense Research Institute (1998).

²*Report on a Space Roadmap for the 21st Century Aerospace Force*, U.S. Air Force Scientific Advisory Board (Nov. 1998).

space systems. The Board recommended that emerging or updated models accurately portray the characteristics and effectiveness of air and space systems. Without appropriate modeling and simulation tools, DOD officials will not be adequately equipped to make informed acquisition decisions.

U.S. Space Command officials informed us that they recently identified the development of modeling and simulation capabilities as a high priority. Also, Air Force officials informed us that they are (1) developing a model, known as the "National Air and Space Warfare Model," to integrate applications of air and space systems to perform analyses of alternatives and (2) undertaking additional initiatives to develop analytical capabilities for comparisons among air, ground, and space systems. In addition, U.S. Space Command officials stated that DOD is taking action to improve modeling and simulation capabilities by developing the "Joint Warfare System" to provide a balanced representation of joint theater warfare. Although the first version of this simulation is to be available in 2002, it will not contain a robust space modeling capability due to funding constraints.

Space Architect's Master Plan Will Not Fully Comply With DOD Policy Guidelines

As discussed in chapter 1, DOD's most recent realignment of space management responsibilities included reorganizing space architect functions. One responsibility of the Office of the National Security Space Architect is to further develop the national security space master plan, and an effort to integrate various space plans into the master plan was initiated in November 1998. This effort included reviewing the U.S. Space Command's long-range plan and the Air Force Space Command's strategic master plan. Architect officials informed us that the various space plans they reviewed may have been useful to the respective organizations that developed them, but the plans did not satisfy the need for an integrated space plan. The current schedule shows that work on the content and structure of the national security space master plan will continue until 2001. When this master plan is completed, the expectation is that it will be a single, consolidated space architecture that uses data from multiple DOD and intelligence space components.

However, according to an Architect official, the national security space master plan will be limited to space systems only and will not provide for comparative cost-effectiveness analyses of land, sea, and air systems. An important aspect of DOD's 1999 space policy is long-range planning that includes developing an integrated national security space architecture, with the purpose of identifying the most efficient and effective balance of space, land, sea, and air systems to minimize unnecessary duplication of

systems within missions and functions. To objectively assess the merits of both space and terrestrial capabilities within specific missions and functions, and to make prudent acquisition decisions within a fiscally constrained environment, a broader assessment to include terrestrial alternatives is essential. If the Architect's office is not organizationally structured to perform such broad assessments, DOD may have to consider changes to accommodate this critical need.

Affordability of Planned Space Systems Is Questionable

The Air Force has the primary responsibility for acquiring most of DOD's space systems, and it spends over 80 percent of the funds that DOD annually budgets for space programs and activities. The Air Force's 18-year program projection includes funding for key space systems identified in the U.S. Space Command's long-range plan. However, we could not verify the extent to which the funding projection supported the plan because estimated costs provided by the Air Force Space Command were not directly traceable to the Air Force's program projection. More importantly, the Air Force's program projection anticipates several billions of dollars in funding increases for space programs during fiscal years 2000-17. However, the availability of such increases are uncertain because their source (1) primarily depends on the actual accumulation of the anticipated government budget surplus and DOD receiving a share of that surplus (on which there is no agreement between the President and the Congress) and (2) is based, in part, on an expectation that a larger share of future DOD budgets would be allocated to space programs. These uncertainties put into question the affordability of planned space systems.

Extent of Air Force Funding Support for Planned Space Systems Could Not Be Verified

The U.S. Space Command's long-range plan does not contain estimated costs for acquiring its planned space systems. However, the Air Force Space Command's supporting strategic master plan does contain an estimate of \$177 billion for the planned systems for the 21-year fiscal year period 2000-20. The strategic master plan is the Air Force's first step in supporting the long-range plan and is developed for use in the Air Force's planning, programming, and budgeting process. However, the strategic master plan expresses doubt about the Air Force's ability to fund the planned systems, stating that the estimated costs contain significant increases in future years at a time when no fiscal growth can be expected in Air Force budgets. To illustrate this potential funding difficulty, the plan stated that to acquire the planned systems, space funding requirements would need to increase to about 20 percent of the Air Force's total obligation authority by 2011, compared to about 9 percent in 1998.

The next step in the Air Force's process is the development by headquarters staff of an 18-year program projection that includes space program priorities and funding that the Air Force has adopted as part of its overall program. The staff uses the strategic master plan as guidance, together with plans from other subordinate commands, to make decisions on space, aircraft, and missile programs. However, we found that the data in the strategic master plan were not directly traceable to the Air Force's program projection because (1) funding data in the plan were too

aggregated for comparison purposes and did not correlate with funding data in the program projection and (2) different program nomenclatures were used.

In addition, Air Force headquarters officials stated that not all of the space programs contained in the strategic master plan can be included in the 18-year program projection, and specifically not at the funding levels that may be needed to fully support a given program. We did, however, determine that the Air Force included several planned systems in its program projection that were also contained in the strategic master plan and the long-range plan. Examples were a space-based radar, space-based laser, space-based data relay, space operating vehicle, and space maneuvering vehicle.

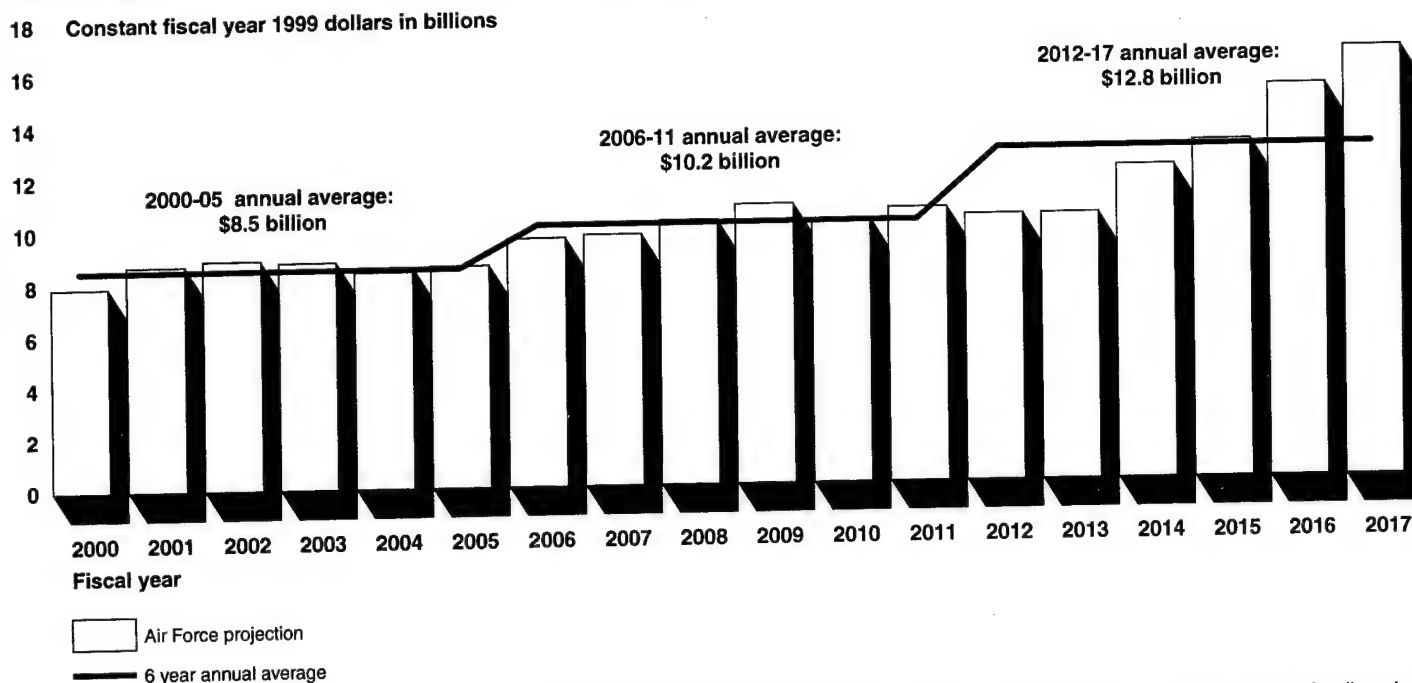
According to U.S. Space Command officials, a priority of the Command is to develop an automated database to track implementation of the long-range plan. Also, Air Force Space Command representatives informed us that they intended to institute a change to make its strategic master plan fiscally consistent with the Air Force's program projection. However, until this adjustment is made, the U.S. Space Command will be unable to determine the extent to which the Air Force is funding programs contained in the long-range plan.

Availability of Funds to Acquire Planned Space Systems Is Uncertain

Within the Air Force's 18-year program projection for fiscal years 2000-17, the first 6 years represent a near-term commitment of resources to programs that are part of DOD's fiscal year 2000 future years defense program.¹ The last 12 years represent mid-term and long-term planning estimates. For the near-term (fiscal years 2000-05) space programs, annual funding averages \$8.5 billion. For the mid-term (fiscal years 2006-11) and long-term (fiscal years 2012-17) space programs, annual projected funding averages \$10.2 billion and \$12.8 billion, respectively. Thus, the mid-term period increases by a total of \$10.2 billion over the near-term period. The long-term period increases by a total of \$15.6 billion over the mid-term period. Figure 2 shows the space funding contained in the 18-year plan.

¹DOD's future years defense program summarizes forces and resources associated with programs approved by the Secretary of Defense and supports the President's annual defense budgets.

Figure 2: Air Force Space Funding Projections for Fiscal Years 2000-17



Notes: For fiscal years 2000-05, the Air Force's annual programmed amounts of space funding shown in figure 2 are not comparable with the annual programmed amounts shown in figure 1. A primary reason is that the Air Force and DOD's Office of the Comptroller define space programs differently. In figure 2, the Air Force includes in space funds, intercontinental ballistic missiles, and certain science and technology programs that may have both air and space applications, whereas in figure 1, the DOD Office of the Comptroller does not. Also, figure 2 is in constant fiscal year 1999 dollars, whereas figure 1 is in then-year dollars. Despite these differences, the overall 18-year program projection by itself provides an indication of the Air Force's space system funding plans.

Excludes space funding for intelligence programs.

Source: Air Force Office of the Deputy Chief of Staff for Plans and Programs.

The Air Force may have difficulty funding its modernization programs in the near-term period because DOD may not receive all the funds that it expects for its fiscal year 2000 future years defense program. DOD plans on receiving increased funding for its 2000 program primarily from a share of the anticipated government budget surplus. However, the prospects for funding from this source are uncertain because (1) the surplus is contingent on continued economic growth, (2) an allocation to DOD is contingent on legislative agreements that address the financial soundness of the Social Security program, and (3) the President and the Congress have not agreed on how much of the surplus to use for increasing DOD's

overall annual funding or how much of any increase would go to the Air Force for space programs.

To the extent that DOD's planned increase in funds in the near-term period do not materialize, the Air Force's anticipated increase in procurement funds for modernization beyond the near-term period might not be realized. DOD has had difficulty in recent years obtaining planned increases in near-term procurement funding because it has had to move those funds to other priorities, such as military readiness. Such movement of funds has resulted in shifting modernization requirements beyond the near-term period. This creates a so-called "bow wave" of demand for procurement funds in later years and is a source of risk to the long-term affordability of DOD's modernization programs. We discussed these matters in prior reports.²

According to Air Force officials, the program projection assumes that funding for space, aircraft, and missile modernization programs in the mid- and long-term periods will increase at the rate of 1.5 percent annually. The officials stated that this assumption is appropriate because it provides for flexibility to introduce new programs into the planning process without having to search for additional funding sources. They also stated that (1) the projection demonstrates a need for additional obligation authority and (2) if the mid- and long-term periods were based on current funding levels, the acquisition of new systems would probably not be feasible.

Air Force officials stated that a larger portion of the DOD budget should be allocated for space programs, given the increased importance of space to military operations. They also stated that space and nonspace systems in the program projection should not be traded against each other in order to reduce projected funding levels. However, in the Air Force Scientific Advisory Board's 1998 report, the Board discussed difficulties the Air Force may have in meeting its aerospace force obligations in future years, suggesting that an unprecedented emphasis must be placed on affordability. Because the Board did not foresee an increase in funding to finance new space capabilities, it suggested that the Air Force consider moving planned funds internally from its nonspace programs to space programs and realign its fiscal priorities by eliminating missions not unique to the military. The Board stated that there are multiple opportunities for

²*Future Years Defense Program: Funding Increase and Planned Savings in Fiscal Year 2000 Program Are at Risk* (GAO/NSIAD-00-11, Nov. 22, 1999) and *Future Years Defense Program: Substantial Risks Remain in DOD's 1999-2003 Plan* (GAO/NSIAD-98-204, July 31, 1998).

the Air Force to become more efficient, to terminate less-effective programs, and to transfer functions that are not essential parts of the Air Force mission to other agencies. Examples suggested by the Board included moving military satellite launches to commercial launch providers and implementing commercial practices and other improvements to satellite operations and tracking.

Insufficient Attention to Space Education

DOD states that the importance of space-based systems and the need for a space-educated force to support military operations were documented during the 1991 Persian Gulf War. Military forces still depend on temporary space support teams established at the end of the war to provide needed expertise on the use of space systems. DOD recently emphasized space education as a priority in its 1999 space policy, establishing a need to incorporate information about space applications and capabilities into professional military education. However, joint doctrine on space operations that contains fundamental principles to guide the employment of forces has not been issued. In addition, the degree to which DOD and the military services have established space education curricula in their postgraduate colleges and schools has varied. These weaknesses require that additional attention be placed on space education to ensure efficient and effective use of space systems in military operations.

Military Forces Still Depend on Temporary Space Support Teams

According to DOD, the 1991 Persian Gulf War was the first military conflict in history to make comprehensive use of space systems. Satellites were used to provide communications, missile attack warning, navigation signals, and weather and imagery data. However, significant effort was required to optimize satellite effectiveness because, in part, military forces lacked the expertise to fully exploit the capabilities that satellite systems provide. After the war, the U.S. Space Command and the military services' space commands established space support teams to provide operational support, education, and training to military forces. Representatives from these space commands informed us that the teams were expected to be a temporary solution and were to be disbanded when a space-educated force was developed. In commenting on our draft report, however, DOD stated that the Army does not have plans to disband their teams because such teams are still needed to support contingency operations. Thus, today the teams are still supporting military operations and exercises and providing education and training—more than 8 years after the conclusion of the war.

Space support teams are normally deployed with two to five members for periods of 1 week to 1 month when requested by theater commanders or other senior military leaders. For example, in 1999 during military operations in Kosovo, joint space teams coordinated the use of space-based assets and provided guidance to U.S. and allied commanders in Europe. Also, an Air Force space support team collected terrain imagery data, making it available to B-1 and B-52 bomber crews for strike missions. In 1999, for operations in Bosnia, Army space support teams provided satellite information for situational awareness, targeting, and mission

rehearsals that included imagery products, weather information, and the effect of solar flare events on terrestrial systems. Also, Naval space support teams provided instructions to naval forces about space capabilities and how to use them during predeployment planning for operations, exercises, and training. According to U.S. Space Command and military service records, the space support teams were used 182 times during a 13-month period, from August 1998 to August 1999. Details are shown in table 1.

Table 1: Number of Space Support Teams' Activities From August 1998 to August 1999

Space support team	Type of activity				Total
	Operations	Exercises	Education	Training	
Joint	3	7	7	1	18
Air Force	16	10	52	11	89
Army	3	28	9	16	56
Naval	3	5	5	6	19
Total	25	50	73	34	182

Source: GAO analysis of space support team records.

Several military space officials informed us that when forces become more space-capable and confident in their ability to request, task, and access space-derived information, the temporary support teams will be disbanded.

Policy on Space-Educated Force Is Formalized, but Doctrine Is Not Issued

The U.S. Space Command's March 1998 long-range plan recommended that information on space applications and capabilities be designated a special area of emphasis in professional military education curricula. The plan reported that such space information was not fully integrated into the curricula and that many military forces do not understand the importance of space systems to military operations. The Command's goal is to integrate space information into core curricula on how space systems affect strategic and tactical warfighting. However, the military services are responsible for implementing this goal.

DOD formally recognized the need to develop a space-capable force with the issuance of its 1999 space policy. In terms of guidelines for space operations, the policy states that information about structure, missions, capabilities, and applications of space forces shall be incorporated into

professional military education, as well as into joint and service training and exercises, to provide appropriately educated and trained personnel at all levels of joint and component military organizations. In his memorandum that accompanied the policy, the Secretary of Defense stated that a space-literate military with the necessary understanding of space operations and the ability to exploit space applications fully is critical to achieve national security objectives. The Chairman of the Joint Chiefs of Staff is responsible for developing joint doctrine for the operation and employment of space systems, formulating policies for joint space training, and coordinating space military education and training for members of the armed forces.

In 1990, the Joint Chiefs of Staff issued directions to the U.S. Space Command to develop joint doctrine for space operations.¹ The intent of the publication is to establish a framework for the use of space capabilities and integrate them into joint military operations; however, the publication has been in draft for several years and had not been issued as of January 31, 2000. According to space officials, the reason for the extended development time is the lack of agreement among the services on how today's space capabilities are to be used during military operations. For example, during the last coordination effort in 1999, the Command received almost 300 comments from the Air Force, nearly half of which were considered significant enough to require major revision to the doctrine. Space officials stated that this doctrine is needed to address DOD space policy regarding the integration of space into military operations and to assist educators in developing space education curricula. We were informed that issuing the doctrine could take another year.

Space Education Curricula Varies

The National Defense University and the military services' postgraduate colleges and schools provide defense-related instruction and professional education to selected military officers and civilian government officials of the United States.² These educational institutions include national security policy and strategy, resource management, and joint warfighting in their

¹The publication we examined is in draft form titled *Joint Doctrine: Tactics, Techniques, and Procedures for Space Operations*, Joint Publication 3-14, Joint Chiefs of Staff (April 1999).

²The National Defense University is under the supervision of the Chairman of the Joint Chiefs of Staff and is concerned with higher education and research in matters relating to national defense.

curricula. In July 1998, the Joint Staff issued guidance to the university and the military services that identified space applications and capabilities as an area that had not been adequately emphasized in professional military education curricula. The guidance was advisory and did not require that such space information be included in the curricula, but it stated that warfighters must know the full potential of current and future space systems. The degree to which the university and the military services' postgraduate colleges and schools have incorporated space information into their curricula has varied, and these institutions lack criteria to determine how much space information to incorporate into their curricula.

Table 2 identifies the prominent DOD and military service colleges and schools that provide commissioned officers with postgraduate education and the number of courses or lessons provided by each institution that are solely space-related. In several cases, however, the educational institutions include space information as a part of the content in courses or lessons that deal primarily with other subject matter. Overall, the courses and lessons identified in the table are not comparable because the length of curricula and the number of instructional hours vary.

Table 2: DOD and Military Service Colleges and Schools and Number of Solely Space-Related Courses or Lessons

Organization	College or school	Core space courses or lessons	Elective space courses or lessons
National Defense University	Industrial College of the Armed Forces, Washington, D.C.	1	1
	Armed Forces Staff College, Norfolk, Virginia	0	2
	National War College, Washington, D.C.	0	1
Air Force	Squadron Officer School, Maxwell Air Force Base, Alabama	0	0
	Air Command and Staff College, Maxwell Air Force Base, Alabama	4	1
	Air War College, Maxwell Air Force Base, Alabama	14	3
Navy	Naval Postgraduate School, Monterey, California	7	0
	Naval War College, Newport, Rhode Island	0	1
Army	Army Command and General Staff College, Fort Leavenworth, Kansas	0	2
	Army War College, Carlisle, Pennsylvania	0	1
Marine Corps	Marine Corps Command and Staff College, Quantico, Virginia	0	0
	Marine Corps War College, Quantico, Virginia	0	0

Note: Core courses or lessons are required for students to complete a particular educational program, and elective courses or lessons provide options to broaden students' understanding of the program under study. The Air Force uses the term "lessons" in its curricula as opposed to the formal "course" designation used by other colleges and schools.

Source: College or school curriculum officials.

Within the National Defense University, the Industrial College of the Armed Forces' curriculum places special emphasis on material acquisition and logistics. A college official stated that because of this focus, space is primarily examined from an industrial viewpoint, with a core course called the "Industry Studies Program." Officials at the Armed Forces Staff College stated that the three schools within the college focus their academic programs on joint and multinational defense matters. An elective course called "Focus Studies" is offered at one of the schools, providing students an opportunity to study a unified command such as U.S. Space Command. A National War College official informed us that within the past 2 years, the college's elective curriculum was modified in recognition that space operations have become an increasingly important component of military operations. The elective course offered is "National Space Policy and Strategy."

The Air Force's Air University at Maxwell Air Force Base, Alabama, includes three colleges and schools that provide professional military

education. For junior officers, the Squadron Officer School provides lessons that contain space content, but it does not provide courses that are entirely space-related because the school focuses primarily on leadership, values, and supervision. For intermediate-level officers, the Air Command and Staff College's curriculum contains several space lessons—examples being "Space in Joint Air Operations Planning" and "Space Assets and Their Impact to the Warfighter." Similarly, for senior-level officers, the Air War College offers a range of lessons that focus entirely on space information—examples being "Future Space Architecture—DOD," "U.S. Air Force Core Competency of Space Superiority," and instructions on military, civil, and commercial space systems. A university official told us that space information has been integrated into lessons with greater frequency, but that more still needs to be done.

In addition to the lessons provided within the Air University, the Air Force offers a recently developed "Aerospace Basic Course" for newly commissioned officers to provide a common understanding of air and space power. Air Force officials also stated that the Space Warfare Center in Colorado offers advanced education and training for military service personnel, DOD civilians, and federally funded research and development contractors. The instruction is directed toward the effective integration of space capabilities into military operations, including the exploitation of defense, intelligence, civil, and commercial space systems. Five courses include advanced education and training oriented toward key personnel who are directly responsible for efforts to integrate space capabilities into combat operations.

According to a Naval Space Command official, the Navy has a strong interest in ensuring that its military officers develop expertise and knowledge on space issues. The Naval Postgraduate School in Monterey, California, offers several courses in its space systems operations program that are solely space-related—examples being "Space Systems and Operations," "Space Technology and Applications," and "Military Space Systems and Architectures." At the Naval War College in Newport, Rhode Island, the Navy offers an elective course on "Space Policy and Operations." According to a college official, contemporary space system planning is adequately covered in the core curriculum.

Although there are currently no core courses in the Army's colleges, the Army Space Master Plan calls for incorporating space into its professional military education curriculum in accordance with time frames established in the U.S. Space Command's long-range plan. In commenting on our draft

report, DOD stated that the Army has developed a curriculum that addresses space operations, but that materials have not been integrated into officer basic and advanced courses. In the interim, the Army's two main colleges have incorporated space information into their elective professional military education curricula. For mid-grade officers, the Army Command and General Staff College provides a "Space Orientation Course" and a "Space Operations Course." For senior officers, the Army War College offers an elective course on "Military Space Operations."

Presently, within the Marine Corps University, the curricula at the Command and Staff College and War College at Quantico, Virginia, do not contain specific space education courses. However, at the Command and Staff College, speakers have been invited from the U.S. and Air Force space commands to address students taking courses with space content. At the War College, a course on "National Security and Joint Warfare" focuses on a war game to provide students the opportunity to apply space principles and concepts learned during the academic year. In addition, according to a War College official, students are taken on 2-day visits to the U.S. Space Command in Colorado. According to a University official, an education master plan is being drafted that will place an increased emphasis on space-based capabilities and their effect on the conduct of naval and military operations.

Conclusions, Recommendations, and Agency Comments

Conclusions

DOD spends billions of dollars annually on military space programs; long-range plans have been developed to expand the use of military space systems, requiring significant increases in funds; and government policy provides considerable latitude for expanding military space systems. However, existing plans do not contain provisions to perform comparative assessments of plausible terrestrial—land, sea, and air—alternatives to acquiring space systems. Also, the necessary modeling and simulation tools are not available to permit objective analyses of such alternatives. As a result of these deficiencies, DOD cannot be assured that the most cost-effective system acquisition decisions will be made to accomplish a given mission. Implementing DOD's current space policy regarding comparative assessments and using modeling and simulation tools is critical because the uncertainty associated with the availability of projected funding increases puts into question the affordability of expanding planned space systems as envisioned by the U.S. Space Command. Additionally, DOD will be hampered in making assessments among space and terrestrial systems until it designates an office and provides the office with the authority to perform the assessments for decisionmakers.

DOD's increasing dependence on space systems for military operations makes it imperative that military personnel are appropriately educated about space system applications and capabilities; otherwise, such high-cost systems are not likely to be efficiently and effectively used. DOD's current space policy provides sound guidance regarding the need to incorporate space information into professional military education; however, this may not be sufficiently achieved until joint military doctrine on space operations, which has been under development for a decade, is issued. Until then, DOD and military service postgraduate colleges and schools will lack guidance for developing space education curricula and for determining whether their existing curricula need to be modified.

Recommendations

To ensure that the most cost-effective decisions are made in regard to planning and programming for space systems, we recommend that the Secretary of Defense direct the Assistant Secretary of Defense for Command, Control, Communications, and Intelligence and, as appropriate, the Under Secretary of Defense for Acquisition, Technology, and Logistics to (1) require that plans in support of space systems include analyses of the estimated costs and potential effectiveness of plausible terrestrial—land, sea, and air—systems as alternatives for performing the identified space missions, functions, or tasks and (2) establish the means to develop and

employ the modeling and simulation tools necessary to perform comparative analyses of space and terrestrial systems. Because the military services can only analyze space and terrestrial systems that are within their organizational purview, the Secretary should also identify and/or establish the proper office, and provide the necessary authority, to perform such analyses for decisionmakers on a DOD-wide basis.

To ensure that military personnel are adequately educated in the use of space systems for military operations, we recommend that the Secretary of Defense direct the Chairman of the Joint Chiefs of Staff to (1) address the delay in completing joint doctrine for space operations by resolving differences among the services and establishing a time frame for issuance and (2) provide the necessary instructions to DOD and military service colleges and schools for incorporating essential space information into their professional military education curricula.

Agency Comments

In commenting on a draft of this report, DOD concurred with our recommendations. DOD stated that our recommendation regarding the need to perform analyses of terrestrial alternatives in planning for space systems is, at least in principle, being implemented through an existing departmental process, specifically citing directions within its acquisition management system. We are aware of DOD's acquisition management requirements whereby such analyses may be performed as early as the concept exploration phase in preparation for a program initiation decision, called milestone I. Often, these analyses are comparisons of like systems, such as whether a new aircraft or spacecraft offers sufficient effectiveness to be worth the cost of replacing an existing aircraft or spacecraft. To the extent that DOD were to employ, during this early phase of the acquisition process, analyses of alternatives that compared unlike systems, such as space systems with plausible terrestrial (land, sea, and air) systems, the results could be favorable.

However, the evidence in this report indicates that analyses of terrestrial alternatives in long-range space planning have not been performed. We did not find that the space plans identified missions, functions, and tasks that could be performed more efficiently and effectively by space forces than terrestrial alternatives, as called for in DOD's space policy. To identify such would have required an evaluation of the operational effectiveness and estimated costs of alternative systems to meet a mission need. Instead, the space plans were aimed at space system solutions only. DOD's space policy characterizes space as a medium for conducting any operation where

mission success and effectiveness would be enhanced relative to other media—land, sea, and air—necessitating a comparison with the other media. Given the increasing national importance of space systems, we believe that DOD should emphasize the application of such analyses of alternatives as early as possible in its decision-making processes—during its requirements generation process, which precedes the acquisition management process, and during the preparation of long-range plans. The results could be even more favorable by providing assessments of the advantages and disadvantages of alternatives to satisfy requirements before programs are initiated and investments are made.

DOD also stated that our recommendation regarding the use of modeling and simulation tools to aid in analyses of terrestrial alternatives is being implemented, in principle, because new tools are being constantly developed and existing tools are being continuously refined. DOD believed that this process was sufficient to ensure that its analysis needs are met. However, we found evidence that DOD lacked the necessary modeling and simulation tools to perform the trade-off analyses essential for making comparisons between space and terrestrial systems. In addition current efforts by DOD to acquire such tools were limited because of funding constraints. To the extent that the necessary tools are acquired and used, decisionmakers will benefit from an ability to select the most cost-effective alternative to satisfy a mission need. As stated in DOD's space policy, models and simulations are to be used to reduce the time, resources, and risks of the acquisition process and increase the quality of the systems being acquired.

In addition, DOD stated that our recommendation regarding the proper office to perform analyses of terrestrial alternatives is, at least in principle, being implemented through existing departmental procedures within the acquisition management system. We are aware of DOD's acquisition guidance that each analysis of alternatives is to adequately define the range of alternatives to be considered. If teams that perform such analyses are able to construct a full range of alternatives under its current departmental procedures that would include adequate comparisons between space and terrestrial systems, greater benefits should accrue. However, we are not convinced that DOD has fully addressed this matter of how proposed space systems would be assessed relative to land, sea, and air systems.

Finally, DOD stated that action would be taken regarding our recommendation about adequate education for military personnel in the use of space systems for military operations. DOD stated that a review

would be performed, under the direction of the Chairman of the Joint Chiefs of Staff, to provide guidance for essential space information that must be present in professional military education and training.

DOD's complete comments are included in appendix I.

Comments From the Department of Defense



COMMAND, CONTROL,
COMMUNICATIONS, AND
INTELLIGENCE

ASSISTANT SECRETARY OF DEFENSE
6000 DEFENSE PENTAGON
WASHINGTON, DC 20301-6000

April 3, 2000

Mr. Louis J. Rodrigues
Director, Defense Acquisitions Issues
National Security and International
Affairs Division
U.S. General Accounting Office
Washington, D.C. 20548

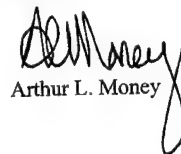
Dear Mr. Rodrigues:

This is the Department of Defense (DoD) response to the General Accounting Office (GAO) draft report, "DEFENSE ACQUISITIONS: Improvements Needed in Military Space Systems' Planning and Education," dated February 18, 2000 (GAO Code 707395/OSD Case 1949).

The detailed DoD comments in response to the GAO recommendations are provided in the enclosure. Suggested technical changes for clarification and accuracy have been provided separately.

The Department appreciates the opportunity to comment on the draft report.

Sincerely,


Arthur L. Money

Enclosure



GAO REPORT – Dated February 18, 2000
(GAO Code 707395) OSD Case 1949

“DEFENSE ACQUISITIONS: Improvements Needed in Military Space Systems’
Planning and Education”

DEPARTMENT OF DEFENSE COMMENTS

Recommendation #1: To ensure that the most cost-effective decisions are made in regards to planning and programming for space systems, the GAO recommended that the Secretary of Defense direct the Assistant Secretary of Defense for Command, Control, Communications and Intelligence and, as appropriate, the Under Secretary of Defense for Acquisition, Technology and Logistics to (1) require that plans in support of space systems include analyses of estimated costs and potential effectiveness of plausible terrestrial--land, sea, and air--systems as alternatives for performing the identified space missions, functions, or tasks and (2) establish the means to develop and employ the modeling and simulation tools necessary to perform such analyses of space and terrestrial alternatives. (p. 9, p. 43/GAO Draft Report)

Now on pp. 11, 40, and 41.

DOD Response: Concur with comment.

The Department believes that it already has in place a formal process for carrying out this recommendation. In particular, for all major acquisition programs, Part 2.4 of DoDD 5000.2 requires that an “Analysis of Alternatives” (AoA) be prepared at appropriate milestone reviews, beginning with program initiation. The AoA is essentially a cost/benefit analysis performed on a range of alternatives. The purpose of the analysis is to illuminate the relative advantages and disadvantages of all of the alternatives under consideration. Responsibility for preparing and issuing the specific guidance for development of each AoA is assigned to various relevant offices within OSD. Among other matters addressed, this guidance is to specifically ensure that a full range of alternatives (e.g., both space- and terrestrial-based alternatives) is considered.

New modeling and simulation tools (for use in preparing the Department’s AoAs, as well as in various other types of analyses) are constantly being developed, and existing tools are being continuously refined. The Department believes that this ongoing process of enlargement and advancement is generally sufficient to ensure that its current and future analysis needs are met.

In summary, the Department maintains that this GAO recommendation is, at least in principle, already being fully implemented through existing departmental processes.

Now on pp. 11, 12, and 41.

Recommendation #2: Because the Military Services can only analyze space and terrestrial systems that are within their organizational purview, the GAO also recommended that the Secretary of Defense identify and/or establish the proper office, and provide the necessary authority, to perform such analyses for decision makers on a DoD-wide basis. (p. 10, p. 43/GAO Draft Report)

DOD Response: Concur with comment.

As in the case of the previous recommendation, the Department agrees that what the GAO recommends is worthwhile, but that the recommendation is, at least in principle, already being implemented through existing departmental procedures. Part 2.4 of DoDI 5000.2 specifically indicates that the OSD guidance prepared and issued for each AoA is to adequately define the range of alternatives to be considered. The team that is assembled to perform the AoA is expected to have adequate representation from all relevant bases of expertise needed to assess each alternative.

Recommendation #3: To ensure that military personnel are adequately educated in the use of space systems for military operations, the GAO further recommended that the Secretary of Defense direct the Chairman of the Joint Chiefs of Staff to (1) address the delay in completing joint doctrine for space operations by resolving differences among the Services and establishing a timeframe for issuance, and (2) provide the necessary instructions to DoD and Military Service colleges and schools for incorporating essential space information into their professional military education curricula. (p.10, p. 43/GAO Draft Report)

Now on pp. 12 and 41.

DOD Response: Concur with comment.

Under CJCS direction, a review will be performed to address the recommendation. This review will result in appropriate DoD guidance to Service academies, DoD and Service colleges and schools that will outline a Joint standard for essential space information that must be present in professional military education and training.

GAO Contacts and Staff Acknowledgments

GAO Contacts

Homer Thomson (202) 512-4841

Acknowledgments

In addition to the person named above, James Elgas, Arthur Gallegos, Maricela Camarena, Dale M. Yuge, and Judy T. Lasley made key contributions to this report.

Ordering Information

The first copy of each GAO report is free. Additional copies of reports are \$2 each. A check or money order should be made out to the Superintendent of Documents. VISA and MasterCard credit cards are accepted, also.

Orders for 100 or more copies to be mailed to a single address are discounted 25 percent.

Orders by mail:
U.S. General Accounting Office
P.O. Box 37050
Washington, DC 20013

Orders by visiting:
Room 1100
700 4th St. NW (corner of 4th and G Sts. NW)
U.S. General Accounting Office
Washington, DC

Orders by phone:
(202) 512-6000
fax: (202) 512-6061
TDD (202) 512-2537

Each day, GAO issues a list of newly available reports and testimony. To receive facsimile copies of the daily list or any list from the past 30 days, please call (202) 512-6000 using a touchtone phone. A recorded menu will provide information on how to obtain these lists.

Orders by Internet:
For information on how to access GAO reports on the Internet, send an e-mail message with "info" in the body to:

info@www.gao.gov

or visit GAO's World Wide Web home page at:

<http://www.gao.gov>

To Report Fraud, Waste, or Abuse in Federal Programs

Contact one:

- Web site: <http://www.gao.gov/fraudnet/fraudnet.htm>
- e-mail: fraudnet@gao.gov
- 1-800-424-5454 (automated answering system)